REMARKS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested. Claims 1-16 are presently active in this case, Claims 1, 7, 12 and 13 amended and Claim 17 added by way of the present amendment.

In the outstanding Official Action, Claim 12 was rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,026,016 to Suzuki et al.; Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Suzuki et al. in view of U.S. Patent No. 4,820,655 to Noda et al.; Claims 14-15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Suzuki et al. in view of Noda et al., and further in view of U.S. Patent No. 5,585,957 to Nakao et al.; and Claim 16 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Suzuki et al. in view of Applicants' disclosure at pages 2-3 of the specification.

First, Applicants wish to thank Examiner Rocchegiani for the March 16, 2004 personal interview at which time the outstanding issues in this case were discussed. During the interview, Applicants discussed the Examiner's position taken in the November 10, 2003 telephone interview. While in that interview, Examiner Rocchegiani indicated that Claims 1-10 would be allowed if Claim 12 was allowed, the subsequent Office Action issued on November 21, 2003 cited new prior art to anticipate Claim 12. As discussed below, Claim 12 has now been amended to overcome the November 21st prior art rejection. Moreover, withdrawn Claim 1 has been amended to include the same limitations added to Claim 12 such that Claim 12 remains as a linking or generic claim to Claim 1 and Claims 1-10 should be rejoined and allowed in the present application if Claim 12 is allowed.

Turning now to the merits, Applicants' invention is directed to a semiconductor optical device including a monolithically integrated EA modulator and DFB laser, as well as a method for forming such an optical device. As described in Applicants' specification, use

of a GaInAsP active region for the DFB laser, while using AlGaInAs as the active region (i.e. the absorption region) of the EA modulator provides improved modulation and temperature characteristics for the optical device.[1] However, the present inventor recognized that when the active region of the laser and the EA modulator are both formed in a mesa stripe configuration, oxidation of the aluminum including active region of the EA modulator causes the characteristics of this active region to change. The present inventor discovered a solution to this problem is to provide the non-aluminum active region of the laser device in a mesa stripe configuration, while providing the aluminum containing active region of the modulator device in a non-mesa stripe configuration (for example, a buried ridge configuration).

While this configuration provides improved characteristics for the integrated laser and EA modulator structure, formation of the laser as a buried heterostructure including a mesa stripe active region and the modulator as a ridge wave guide conventionally required independent photolithography steps, and may result in an alignment error between the laser device and EA modulator. Thus, the present inventors further discovered a selective dry-etching technique used to simultaneously etch a mesa stripe configuration that extends into the nonaluminum active region of the laser device, while not extending into the aluminum base active region of the EA modulator. For example, a Br plasma etching technique may be used to etch the mesa stripe configuration wherein the aluminum based active region of the modulator acts as an etch stop layer to such an etching process. This etching process provides a simple simultaneous photolithography process that substantially avoids alignment errors between the laser active region and modulator active region, and further provides better reproducibility and higher yield in the integrated laser-modulator configuration.

In order to expedite issuance of a patent in this case, Applicants have now amended Claims 1 and 12 to recite that the DFB laser active region is a non-aluminum based active

[1] See Applicants' specification at page 8, paragraph 46.

region having a mesa stripe configuration, and the multilayer EA modulator active region is an aluminum based active region not having a mesa stripe configuration.

In contrast, the newly cited reference to Suzuki et al. discloses an integrated laser device and modulator device both having an active region in a mesa stripe configuration (i.e. both having a buried heterostructure configuration. More specifically, as seen in Figure 6b of Suzuki et al., both the multilayer laser device and the multilayer modulator are formed in a mesa stripe configuration that extends through the active region of these devices. Thus, Suzuki et al. does not disclose a modulator device active region not formed in a mesa stripe configuration as now claimed in Claims 1 and 12. Therefore, independent Claims 1 and 12 patentably define over the cited reference to Suzuki et al.

With regard to the cited reference to Noda et al., while this reference discloses forming a laser device and modulator in an integrated device, this reference does not disclose whether the laser device or the modulator device have a mesa stripe structure. As discussed in the March 16th interview, the mesa stripe structure is a laser structure that is narrowed in a direction perpendicular to the light emitting direction. More specifically, Figure 1 of the Applicants' specification shows a *side view* of the integrated laser-modulator device wherein light is generated in the laser region 10a and emitted from the right side of the modulator 10B. Cross section lines I and II of Figure 1 designate cross section planes for the laser and modulator respectively. Figures 2A and 2B of the specification show a *front face* view of the laser and modulator at the cross section planes I and II. As seen in these figures the mesa stripe structure is narrowed in a width direction perpendicular to the light emitting direction (the light emitting direction being perpendicular to the page). Such a "stripe" structure provides a narrow current path that improves the operating characteristics of the laser or modulator device.

In contrast, Noda et al. discloses an integrated laser-modulator structure wherein the electrodes are separated by a V shaped trench. The figures of Noda et al. (in particular Figure 4E referred to in the March 16th interview) show a *side view* of the laser-modulator device similar to that of Figure 1 of the Applicants' specification. The V-shaped trench separates the electrode of the laser device from the electrode of the modulator. This trench is a common technique for electrically isolating the electrode of the laser device and the modulator device to ensure independent current operation. However, Noda et al. does not disclose a front face view showing a mesa stripe configuration as claimed in Applicants' independent Claim 12. Indeed, the text Noda et al. does not mention a mesa stripe structure at all. Therefore, Noda et al. also does not disclose the limitation of the laser device having a non-aluminum based active region with a mesa stripe configuration and the modulator device having an aluminum based active region not having a mesa stripe configuration.

Finally, with respect to the cited reference to Nakao et al., this reference is cited for teaching the selective etching feature of the present invention. While this reference discloses a dry etch process involving a methane based bromine species, this etch process is disclosed with respect to forming a single laser and not with respect to forming a monolithically integrated laser device and modulation device as with the present invention. Moreover, the etch process used to form the trenches 4 in Figure 9b etch through the active region 6 to form this active region in a mesa stripe configuration. That is, the dry etch process of Nakao et al. is not used to ensure selective etching between the active regions of a laser device and a modulator device as with the present invention. As discussed above, the present inventors developed this selective etching process in order to provide an integrated laser-modulator device having a mesa stripe laser active region and a non-mesa stripe modulator active region in a simultaneous etching process. Therefore, one of ordinary skill in the art would not be motivated to combine the dry etching process of Nakao et al. with the laser-modulator device

of either Suzuki et al. or Noda et al. without Applicants' discovery that this etching process provides a desirable selective etching between an aluminum based and non-aluminum based active region.

Finally, with respect to new claim 17, as discussed in the March 18th interview, this claim has been added to emphasize the selective etch feature of the present invention that can be used to provide different mesa stripe etch depths in the laser and modulator regions. Specifically, Claim 17 recites simultaneously etching said laser formation area and said modulator formation area such that the multilayer structure of a DFB laser is selectively etched to a deeper depth that the multilayer structure of an EA modulator. None of the cited references teach or suggest such a selective etching of a laser region relative to a modulator region in an integrated laser-modulator device. In this regard, Applicants acknowledge the Examiner's position taken in the March 16th interview that the trench of Figure 4E extends partially into layer 3 of the modulator region, while not extending into layer 13. Applicants note that this is not the result of a selective etching process, but rather the result of different thicknesses of layers 13 and 3. Moreover, it is clear from Figure 4E that the trench extends to equal depths in the laser and modulator area.

For the reasons discussed above, Applicants' Claims 1, 12 and 17 patentably define over the cited references to Suzuki et al., Nakao et al., and Noda et al., alone and/or in combination. Moreover, as Claims 2-8 depend from Claim 1 and Claims 13-16 depend from Claim 12, these claims also patentably define over the cited references.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application and the present application is believed to be in condition for formal allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

Customer Number
22850

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Edwin D. Garlepp

Bradley D. Lytle
Attorney of Record
Registration No.: 40,073
Edwin D. Garlepp
Registration No. 45,330

Tel: (703) 413-3000
Fax: (703) 413 -2220
(OSMMN 08/03)

BDL/EDG/tdm
I:\ATTY\EDG\1294-FURUKAWA\216449US - P1494\216449 AM 11.21.03OA.DOC